rapidly, and after accepting the probability that in some way or other the earth and atmosphere have received compensating accretions slowly by the fall of meteorites without an appreciable increase of temperature, he proceeds to work out this idea more in detail, finding many analogies in the present condition of the moon. In general, our atmosphere was derived from the interior of the earth, but after the earth had reached the requisite size, it would be supplemented by the collection of wandering gases. All this, of course, took place while the temperature of the surface was above that of boiling water and before the ocean, as such, could exist. The combined mass of the atmosphere and the ocean are little more than $\frac{1}{5000}$ of the mass of the earth. At that time the matter that now constitutes an earth of average specific gravity 5.6 was so swollen by heat as to have an average of 3.5. If we consider this mass as simply contracting to its present dimensions, the corresponding fall of each particle toward the earth's center would, by the conversion of gravity into heat, be capable of raising the whole mass to a temperature of 6,560° C., or far above the average melting point of rocks on the surface. Whether or not the earth and atmosphere ever went through this particular stage in progressive self-condensation, it is at least probable that something like that must have gone on in connection with the formation of the ocean depressions and continental elevations and the subsequent great crumplings and crushings of Archæan ages.

The mountainous wrinkling of the crust in Post-Cambrian times is now going on in this epoch in gentle earthquakes. * * * There does not, therefore, seem to me any firm ground, even on current theories of the earth's origin, for insisting on the acceptance of the doctrine of a vast primitive atmosphere, as the great reservoir from which subsequent abstractions have been chiefly taken. I think we are free, therefore, to assume just such a Paleozoic atmosphere as the life and deposits of that time seem to imply, interpreted by the phenomena of to-day. Such an interpretation seems to me to indicate conditions not radically dissimilar to those of the recent geological ages; warm climates in high latitudes at times, colder climates in lower latitudes at times, moisture at times, aridity at times, and like oscillations. This view carries with it the necessary corollary that the atmosphere has been suppliedby accessions in some new proportion to its losses.

The author then gives some plausible reasons for the fluctuation in supply and exhaustion of the atmosphere; among these it is noticed that when a general uplift of the crust occurs the area of the ocean is diminished and the area of high land increased with an increase of the atmospheric exhaustion or impoverishment, so that, in general, atmospheric poverty lags some distance behind the stages of general elevation and *vice versa*. The author also assumes that atmospheric poverty, especially in the critical item of carbon dioxide is correlated with low temperatures. Tyndall suggested that carbon dioxide had a peculiarly powerful influence in absorbing solar radiation, and Arrhenius has lately computed what degree of depletion of the carbon dioxide at present in the atmosphere would bring about the glaciation known to have prevailed in Pleistocene times. He finds that the removal of 38 to 45 per cent will do this and that, on the other hand, an increase of two or three times its present value would produce the mild temperatures of the Tertiary times. But the elevation of a continent, the resulting glaciation and diminution of forests, or other plant life, eventually checks the absorption of carbonic acid gas, and by leaving more of it in the air, contributes to warm the atmosphere and check the glaciation. We have, therefore, an alternation of cold and warm periods due to the interaction of elevation and carbon dioxide.

Meteorologists and climatologists will certainly be pleased to find geologists agreeing that the climatic peculiarities of Pleistocene and subsequent ages were due to an atmosphere similar to that which now envelopes the earth; that oceans and continents in those days were not so greatly different from the present day, and that the great climatic changes required to cover the interior of the United States and Canada with a vast glacier similar to that which now covers Greenland, may have been brought about by a redistribution of highlands and lowlands. The problems of geological climatology are thus brought within the realm of the modern climatologist. The arguments that apply to existing climates will also apply to those of earlier eras. When we can explain why it is that glaciers are now formed in Greenland but not in our Lake region then we shall be able to state the conditions under which formerly glaciers were formed in the Lake region but not in Greenland. To the Editor these seem to be merely questions of aerodynamics.

Given a certain distribution of highland, lowland, and ocean over the whole earth's surface, we hope eventually to be able to deduce the resulting climatic peculiarities, and to show that very slight changes in oceans and continents have produced all the variations of geological climates, and that little or nothing need be hypothecated as to the variations of solar heat, of atmospheric gases, of terrestrial latitudes, or the many other climatological elements.

BAROMETRIC READINGS CONVERTED INTO STANDARD PRESSURES.

In the Annual Report of the Chief Signal Officer for 1881, pages 1126–1137, will be found a study of the corrections to the standard mercurial barometer of the Signal Service, in which instrument English scales and Fahrenheit thermometers are used. In this work it was proper to assume that the temperature of the brass scale and that of the mercury inside of the glass tube might differ appreciably, possibly by several degrees. Therefore thermometers were so placed as to give each of these temperatures separately. Two tables were computed, which were published at the close of the article referred to, by means of which the correction for temperature of the scale might be obtained and applied independently of the correction for the temperature of the mercury.

In using these and similar tables of corrections, it is assumed that the zero of the scale is precisely at the end of the ivory point to which the mercury is adjusted in the cistern of the barometer, so that, for instance, 30.500 on the brass scale really means that exact number of apparent inches on a brass scale whose coefficient of expansion for 1° F. is 0.0001043 of the observed length. It is also assumed that the average temperature of the scale is exactly known by means of several thermometers, if need be, whose individual errors have been allowed for. It is furthermore assumed that the brass scale is of correct standard length only when its temperature is 62° F. If b'' is the observed scale reading or "apparent length," and t'' is the observed temperature of the scale, then the correction for the reduction of the scale to standard length is computed by the formula:

$$\text{Correction} = b''\ (t'' - 62°)\ 0.0001043.$$

This formula is represented by the following abstract of Table I:

TABLE I.

t''.	b''=29.5.	b''=30.5.
°*F.*	*Inch.*	*Inch.*
30.....	−0.0098	−0.0102
40.....	0.0068	0.0070
50.....	0.0037	0.0038
60.....	−0.0006	−0.0006
70.....	+0.0025	+0.0025
80.....	0.0055	0.0057
90.....	0.0086	0.0089
100.....	+0.0117	+0.0121

Having corrected the brass scale reading so as to get the height of the mercurial column in standard inches, we must now correct this latter height for the influence of the temperature of the mercury on its density. The density of mercury at the melting point of ice, or 32° F., is adopted as the standard, and the correction that we now need is computed by the formula:

$$\text{Correction} = -b' \frac{(t' - 32°)\,0.000101}{1 + (t' - 32°)\,0.000101}$$

which formula is represented by the following abstract of Table II. In this abstract the Editor has adopted the international value 0.000101, instead of the 0.0001001 that was used in 1880.

TABLE II.

t'	$b' = 29.5.$	$b' = 30.5.$
F°	*Inch.*	*Inch.*
30	+0.0060	+0.0062
40	−0.0238	−0.0246
50	−0.0536	−0.0454
60	−0.0832	−0.0860
70	−0.1128	−0.1166
80	−0.1424	−0.1471
90	−0.1719	−0.1777
100	−0.2012	−0.2080

These two tables may be combined into one if the temperatures of the scale and the mercury are identical.

After these two corrections have been applied to the original scale readings, the next step is to correct for the influence of capillarity, imperfect vacuum, erroneous density of mercury, error in zero of scale, and other instrumental matters. All of these are minutely investigated before using the so-called normal barometers, such as those at the International Bureau of Weights and Measures at Sevres, near Paris, but it would be impossible to study them in such detail at every meteorological station, therefore, before using any station barometer, it is compared with these international normals, either directly or through an intermediate portable barometer. Such comparisons give a small correcrection that sums up all the constant outstanding differences, and which is known in the Weather Bureau as the *correction for instrumental error and capillarity*, or more properly, the *constant correction* as distinguished from the variable ones that depend on pressure, temperature, and time. It is also known as the *reduction to Kew*, or *to Washington*, or *to Sevres*, according as one or the other is adopted as standard.

After applying this small constant correction, as well as the two above-described corrections for temperature, the result is called the apparent barometric pressure, viz, the pressure of the atmosphere as measured by the true height in standard English inches of a column of metcury having the standard temperature of 32° F., and whose weight or downward pressure is that due to the local force of gravity.

It would be more in accord with our ordinary methods of measuring pressures if we should express the atmospheric pressure in pounds per square inch, as we do the steam pressure in an engine boiler; at sea level our atmospheric pressure varies between 14 and 16 pounds to the square inch, and the height of the barometer varies in a corresponding manner between 28 and 31 inches; even although we speak of a pressure of 30 inches, yet it must always be remembered that we mean a pressure of about 15 pounds to the square inch, or one that will sustain a column of mercury 30 inches high.

The elastic force or the pressure of steam within the boiler depends upon its temperature, and for the same temperature the pressure would be the same, no matter whether the boiler were at the North Pole or at the equator. The pressure of the wind depends upon the velocity and the density of the air. In all meteorology we measure velocities, rainfall, and temperatures by standard measures which are the same the world over, but when it comes to atmospheric pressure we have too long allowed ourselves to retain the custom introduced by Torricelli and measure it by the height of a cylindrical column of mercury, whose pressure at the bottom is its total weight, which must vary with the force of gravity, so that 30 inches of mercury at the equator means a less pressure per square inch than 30 inches at any other latitude up to either Pole. If we wish to express pressures in a uniform standard measure, or as we ordinarily say in standard units, we must pass from apparent to true pressure by allowing for the difference between the local force of gravity and some adopted standard value of that force, such as its value at sea level and at the latitude of 45°. We might measure pressure by using some barometric apparatus, such as the aneroid barometer or the thermo-hypsometer, whose indications are not affected by gravity, but if we use the mercurial barometer then its readings must be corrected for gravity, that is to say, they must be reduced to standard gravity. The reduction necessary, on account of the variation of gravity with latitude, may be obtained from tables published by the International Meteorological Committee of which the following Table III is an abbreviation:

TABLE III.

Latitude. (N. or S.)	Relative force of gravity.	Reduction of mercurial barometer to standard gravity.		
		27.0	29.0	31.0
		Inch.	*Inch.*	*Inch.*
0°	0.9974100	−0.070	−0.075	−0.080
10°	0.9975662	−0.066	−0.071	−0.075
20°	0.9980159	−0.054	−0.058	−0 062
30°	0.9987050	−0.035	−0.038	−0.040
40°	0.9995503	−0.012	−0.013	−0.014
50°	1.0004497	+0.012	+0.013	+0.014
60°	1.0012950	+0.035	+0.038	+0.040
70°	1.0020409	+0.054	+0.058	+0.062
80°	1.0024338	+0.066	+0.071	+0.075
90°	1.0025902	+0.070	+0.074	+0.080

But the force of gravity also diminishes slightly as the altitude increases above the earth's surface. Consequently at great altitudes any given height of the mercurial column corresponds to a pressure that would at sea level be measured by a somewhat shorter column. If, therefore, we measure atmospheric pressure by means of the height of a column of mercury we must add a second slight gravity correction for the height of the barometer above the sea level, and this correction is also expressed in a table of the international collection, of which the following is an abstract:

TABLE IV.

Altitude of station.	Barometric pressure.				
	18 inches.	21 inches.	24 inches.	27 inches.	30 inches.
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1,000 feet	....	....	−0.001	−0.002	−0.002
5,000 feet	....	−0.007	−0.007	−0.008	....
10,000 feet	−0.011	−0.013	....	....	....

In general, it will be seen that at low altitudes and for ordinary pressures this small correction amounts to about 0.001 for every 500 feet of altitude, but is only one-half of this amount when the altitude has attained 10,000 feet. Considering the world at large we may say that the corrections for gravity depending on latitude and altitude amount to about one-third as much as the corrections for the temperature of the mercury and the brass scale respectively.

We now have true instead of apparent atmospheric pressure expressed in inches on a system that is uniform, no matter what the latitude, altitude, or temperature, and if we wish to convert these inches into the more appropriate terms "pounds to the square inch" we have only to multiply them by 0.4906, which is the weight in pounds of a cubic inch of mercury, whose temperature is 32° F. Consequently a pressure of 30 standard inches corresponds to a weight under standard gravity of 14.718 pounds to the square inch. If measurements by the mercurial barometer are always corrected for the variations of gravity, and then converted by means of this latter constant factor, we shall obtain true pressures in pounds per square inch that are directly comparable with each other, no matter where the barometer may be located.

NOTES FROM THE JULY REPORTS OF THE CLIMATE AND CROP SECTIONS.

ARIZONA.

This is one of the most interesting States from a meteorological point of view. For many years the low pressure during the summer months was a conundrum that seemed impossible of explanation, but now we have every reason to believe that Arizona must be regarded as lying at the northern extremity of a narrow region of low pressure that extends from the equatorial Pacific northward over the Gulf of California; as soon as this was made clear it was seen that the low pressure in the summer at Yuma was not a local statical phenomenon but a part of the general feature due to the dynamics of the atmosphere, and depending, therefore, upon the winds and upper currents in the air. As this area of low pressure shifts its position slightly there occur local storms, but both the shifts and the local storms must be considered as the results of atmospheric changes going on at a considerable distance. For instance, on July 13–14 pressure was low in Arizona and the Gulf of California, while it was high on the coasts of California and Oregon. These conditions resulted in cloud-bursts and other local storms reported on the 15th and the wind and sand storms with light rain on the 16th. In general a flow of air southward through Arizona means a descent from high plateaus to sea level, which usually brings warm, dry clear weather to the lowlands. The present month, however, was normal as to temperature, with rainfall slightly in excess.

GEORGIA.

On the 1st at Marietta heavy thunder came from an almost cloudless sky, then a small cloud appeared and in ten minutes hail was falling. This is a pretty illustration of the origin and growth of local storms. One can scarcely doubt but that this small cloud grew in ten minutes to be a large one by virtue of the rapid ascension of a large mass of air, and the equally rapid descent of a similar mass in some neighboring region.

A similar purely local storm occurred on the 23d at Atlanta, where 4.32 inches fell in two hours, and half of that in forty minutes. The storm was purely local, so that points a mile or two from the city had comparatively little rain. Although the storm is said to have moved from southwest to northeast, yet, it would seem from this to have scarcely moved at all. In fact there are so many similar cases on record that one can not doubt but that very often a mass of moist air ascending nearly vertically carries up not only the moisture that is to be condensed and fall as rain, but an additional mass that ascends a little farther, then overflows and subsequently descends as dry air. It may be difficult to explain why such a stream of ascending air should remain within a mile or two of being stationary for two hours but, in general, we may say that under areas of high pressure the general horizontal movement is so gentle that if a mass of moist air once acquires a decided tendency to rise there is no special reason why it should not ascend vertically followed by other air in the same line of flow and constitute a complete vertical circulation of ascent and descent. A remarkable illustration of this same character occurred in August, at Washington, D.C.

ILLINOIS.

But twelve stations reported more than 2 inches of rainfall on any one day during the month and those mostly in the southern districts, therefore, when Elgin reports a very violent thunderstorm on the evening of the 19th, with some symptoms of a tornado, and yet measured only 0.043 inches of rain, we are constrained to note that the expression "very violent thunderstorm" seems to us rather misleading. The prominent characteristics of the thunderstorm may be either lightning, thunder, wind, hail, one or all of these. It would be more precise if one could make the entry read thus: "Storm with violent wind," or "with heavy rain," or "with excessive lightning and thunder." The International system of symbols could also be applied with clearness and economy of space, thus: "Storm on the 19th., lightning^2, thunder^2, rain^0, hail^0, wind^1." Here we have all the meteorological phenomena briefly recorded with as much accuracy as is ordinarily called for. (See the International Meteorological Symbols on page 311, of this number of the MONTHLY WEATHER REVIEW.)

IOWA.

An extraordinary rainfall, continuing three hours and amounting to 12 or 13 inches, is reported at Blanchard, on July 6. Blanchard is in Page County, in the southwestern corner of the State, and this record harmonizes with the report from Missouri for the same afternoon and evening, except only that the highest measurement was 8.15. There seems to have been a tendency to very heavy rain west of Iowa and Missouri in Nebraska and Kansas, as shown by the morning weather map of that date. The surface winds had been flowing from the southeast for two days and the general features of the maps for July 6–7 illustrate a principle that has been remarked ever since the first summer of study of the daily weather map, namely, that the flow of air from the south and east can not carry moisture up the western plains to a height of 1,000, 2,000, or 3,000 feet without being followed by severe local rains in the eastern portions of Indian Territory, Kansas, and Nebraska, and the western portions of Arkansas, Missouri, and Iowa. Somewhere in its gentle ascent this air must flow over on itself, which overflow is stimulated by the sun's action in heating the ground and lower stratum of air.

The Iowa reports are always full of interesting reading matter. We note among other things a short extract from Mr. E. J. Prindle's article on weather forecasts, who says: "The first attempt at scientific forecasting of the weather was the result of a storm which during the Crimean war, November 14, 1854, almost destroyed the fleets of France and England." The Editor may remark that the distinguished French astronomer, Leverrier, gives some account of the inauguration of daily telegraphic bulletins and weather predictions in France in the historical introduction to the first volume of his Atlas of the General Movements of the Atmosphere. In 1854 he was one of the most active astronomers of the world, but at that time the Paris Observatory busied itself only with its own local meteorological observations as a single station. It was Leverrier who noticed the apparent bodily movement of the storm in the neighborhood of the Crimea, in November, 1854, and who spoke of it to the Minister of War, Marshall Vaillant, thereby leading the latter to ask him, as the foremost scientist of the French Government, to investigate that storm, and eventually to organize at the observatory a bureau for the collection of weather telegrams and the prediction of storms. In February, 1855, Leverrier submitted definite proposals for this object, and his system of daily bulletins for French stations only, began in 1856. In 1858 this bulletin assumed the form of a regular publication, and was eventually extended so as to cover the whole of Europe, and became the Bulletin International. A first